NORTHROP
CONSULTING ENGINEERS

Grafton Bond Store
60 Hickson Road
Sydney NSW 2000

PO Box H171
Australia Square NSW 1215

Telephone (02) 9241 4188
Facsimile (02) 9241 4324
Email sydney@northrop.com.au

# WAGGA WAGGA PLANNING STUDY

# COPLAND STUDY AREA

# ENVIRONMENTAL STUDY - STORMWATER

**JOB NUMBER: 07519**

**REVISION: 3**

**DATE: September 2008**

Prepared by:
S. Fryer
Northrop Engineers

Prepared For:
Wagga Wagga City Council

Reviewed by:
M. Richards
Northrop Engineers

## TABLE OF CONTENTS

## 1.0 Copland Study Area

The Copeland Study Area is located to the east of the Wagga Wagga Town Centre. The site is bounded by Copeland St to the north, Marshalls Creek to the west, a drainage channel to the east and rural land to the south. The site occupies an area of 22.6 ha.

The site is generally level with a slight fall to the south west. The level of the subject area is typically consistent with the adjacent roadway.

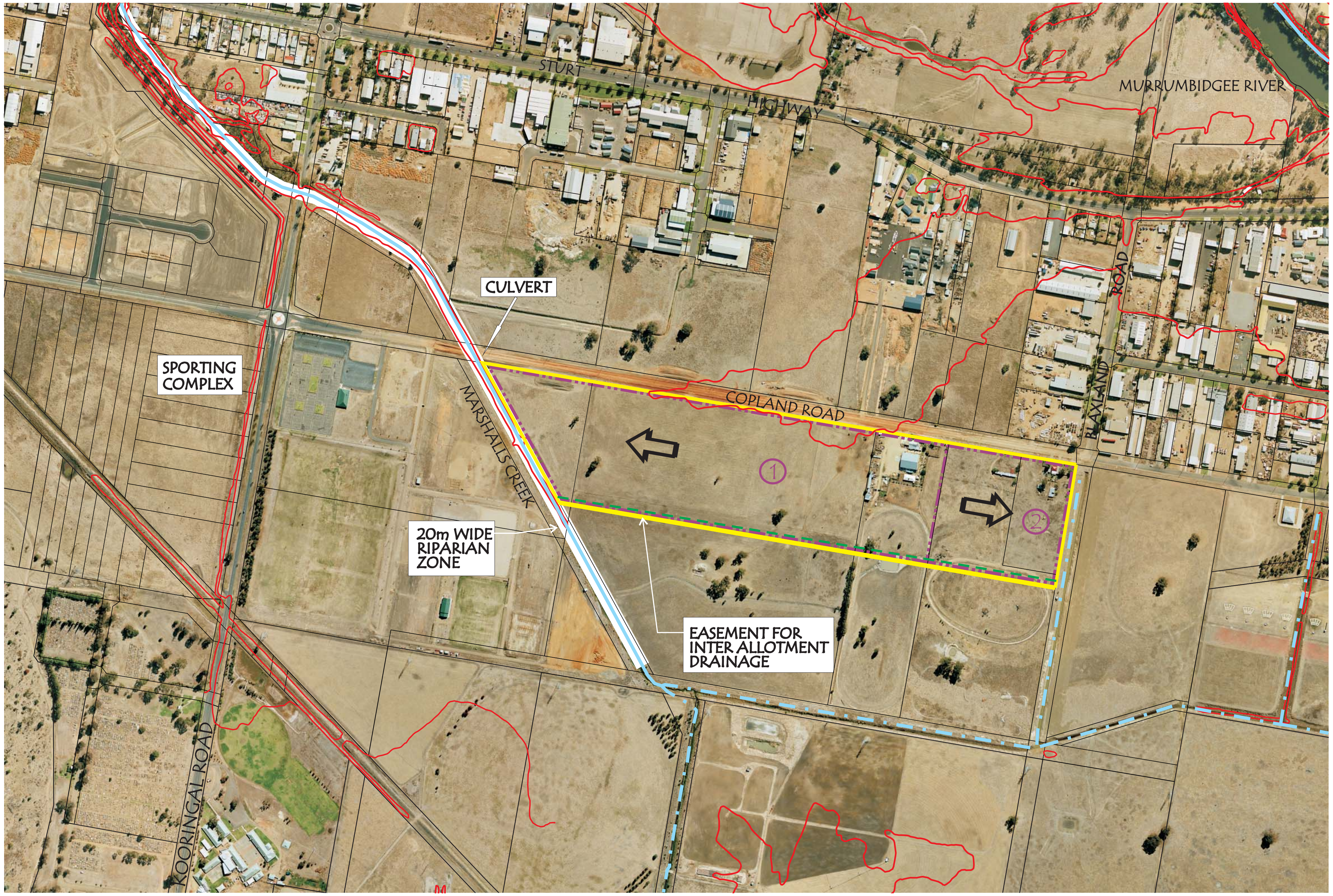
The site has been identified as flood liable due to the Murrumbidgee River overtopping its banks.

Photo 1.0 Copland Study Area

A small part of the Study Area has been developed for industrial uses. The remaining undeveloped portion is vegetated with grazing pasture and utilised for rural any purposes. Figure 1.0 shows the extent of the site and key features.

## 2.0 Hydrology

The site is located in the floodplain. The land is relatively flat which makes the definition of respective site catchments difficult. The site can be divided into two catchments. Catchment 1 drains to Marshalls Creek. Catchment 2 drains to a drainage channel adjacent to the eastern boundary. Figure 1.0 shows the extent of the catchments. There are no watercourses or depressions present on site that naturally concentrates surface flows.




# COPLAND STREET STUDY AREA

FIGURE 1.0

APPROX. SITE AREA=22.4ha

CATCHMENT No.1=17.2ha

CATCHMENT No.2=5.2ha

## LEGEND



Scale 1:8000

NORTHROP

## 3.0 Stormwater Drainage

No formal drainage systems are present on the site. Stormwater runoff from the existing buildings flows to a table drain adjacent to Copland Road. This table drains extend along the entire northern boundary of the site and discharges to Marshalls Creek. An ope channel abuts the eastern boundary of the site.

Photo 3.1: Table drain adjacent to Copland Rd

Photo 3.2: Table drain discharging to Marshalls Creek

Photo 3.3 & 3.4: Drainage channel to east of site

## 4.0 Existing Site Runoff Quality

Existing site runoff quality has been considered based on the current usage of the Study Area. The following table identifies potential sources of contaminants for the site under pre-developed conditions. The risk of contamination to watercourses due to current usage is considered to be minor.

Table 4.1 Existing Potential Contaminant Source

| | Contaminant | | | | | | |
|---|---|---|---|---|---|---|---|
| **Catchment** | **Solids** | **Nutrients** | **Micro-Organisms** | **Dissolved Oxygen Demands** | **Metals** | **Oils** | **Synthetic Organics** |
| All Catchments | Soil Erosion<br>Cleared Land<br>Animal Waste<br>Industrial Chemicals<br>Vehicle Fuels and Fluids<br>Industrial Processes | Soil Erosion<br>Cleared Land<br>Animal Waste<br>Fertilisers<br>Industrial Chemicals | Cleared Land<br>Animal Waste | Soil Erosion<br>Animal Waste | Soil Erosion<br>Fertilisers<br>Pesticides<br>Industrial Chemicals<br>Vehicle Fuels and Fluids<br>Industrial Processes | Pesticides<br>Industrial Chemicals<br>Vehicle Fuels and Fluids<br>Industrial Processes | Pesticides<br>Industrial Chemicals<br>Vehicle Fuels and Fluids<br>Industrial Processes |

Northrop has undertaken preliminary analysis to estimate annual pollutant loads for the Copeland Study Area. “MUSIC” water quality modelling software was used. Results of the initial modelling are summarised below.

Table 4.2 Estimated Annual Pollutant Loads

| Catchment | Annual Flow (ML/year | Total Suspended Solids (kg/year) | Total Phosphorus (kg/year) | Total Nitrogen (kg/year) | Gross Pollutants (kg/year) |
|---|---|---|---|---|---|
| Copeland | 10.14 | 42 | 1.8 | 15 | 0 |

## 5.0 Built Environment

Northrop has prepared the following Planning and Development Guidelines for Stormwater Drainage and Flooding. The Guidelines have been based on the Copeland Study Area being rezoned for commercial or industrial purposes.

### 5.1 Stormwater Planning Matrix

The Planning Matrix below identifies stormwater planning and design issues that must be resolved during development planning of the site. Appendix A provides a detailed description of the notation and terminology referred in the Planning Matrix.

Table 5.1.1 Stormwater Planning Matrix

| Study Area | Primary Land Use | No. Of "Blue Lines" | No. of C'ments | Upstream C'ment | Site Discharge Controls | Salinity Controls | Flood Liable Land | Stormwater Quantity | Stormwater Quality | Rainwater Re-Use |
|---|---|---|---|---|---|---|---|---|---|---|
| Copeland | Ind | 1 | 1 | No | None | No | FL1 | Q2 | QB, QD | RA |

## 5.2 Stormwater Quantity Management

As the site is flood liable and located at the lower end of the catchment it is preferable to discharge all stormwater runoff generated from the site as early in the storm event a possible. In such a situation it is preferable not to detain stormwater runoff.

Industrial sites have high impervious area ratios which resulting in greater runoff volumes. It is expected that up to 90% of the site could be impervious for such development. Therefore consideration is to be given to the existing downstream drainage system and its capacity to receive the changed runoff volumes and patterns from the site. Acceptable stormwater quantity management measures would demonstrate that no adverse impacts elsewhere in the catchment are created as a result of development.

Future stormwater quantity management policy for the site shall incorporate a provision to forego on-site detention if it can be demonstrated no adverse impacts are caused due to development.

Stormwater quantity management strategies may include rainwater re-use, minimisation of impervious areas or incorporation of permeable pavements. Rectification/augmentation of existing drainage infrastructure may also minimise the impacts of development.

Inter-allotment drainage will be required. It is envisaged inter-allotment drainage (within an easement) would be located parallel to the southern site boundary. The site's piped stormwater drainage system shall be sized to accommodate the 1 in 20 year ARI. Overland flow paths shall be design so that they protect proposed buildings and the lands to north from flooding due to the 1 in 100 year ARI storm. Future development of the lands to the south may need to be considered when selecting flow paths. Figure 1.0 show the proposed location of an easement for inter-allotment drainage.

## 5.3 Stormwater Quality Management

Industrial development has potential to significantly increase pollutant loads in stormwater runoff. This is particularly dependent on the type of industry. On this basis, stormwater quality management should be undertaken on an individual Lot basis to target specific contaminants being generated from industrial sites.

In general, the concepts, principles and controls specified in Appendix C and D must be considered when implementing a water quality management strategy for the site.

### 5.4 Rainwater Re-Use

Rainwater harvesting and re-use schemes are encouraged for all development.

The provision of rainwater re-use systems has significant positive impacts in reducing the volume and quality of stormwater runoff generated from the developed site.

The provision of no rainwater reuse system will only be considered where significant negative impacts are demonstrated (e.g. ownership / operational issues, site salinity, interruption to the water cycle, public health issues, etc.).

Rainwater re-use promotes water conservation and underpins any strategy incorporating Water Sensitive Urban Design. In this regard, rainwater re-use systems have the potential to:

- Decrease the quantity and rate of stormwater runoff from a catchment;
- Decrease demand on the potable water supply; and
- Decrease the pollutant load of stormwater discharged from a catchment.

Treatment of harvested stormwater needs to be considered to suit its intended purpose. This will involve researching the level of treatment and on-going monitoring and maintenance necessary to minimise risks of contamination to end-users and operators of the subject facility.

## 6.0 Flooding

As the site is flood liable future development shall considering the impacts of flooding. Development of the site shall be in accordance with the guidelines of the NSW Floodplain Manual. Habitable floor levels are to be located a minimum 500mm above the 1 in 100 year ARI flood level. Evacuation routes shall also be provided in the event of flood. Flood planning levels shall be based upon studies and historical data available from Council.

Flood storage is the volume of water detained on the flood plain during a flood event. A reduction in flood storage due to development (i.e. construction of buildings or filling operations) can have detrimental impacts. Increase flood levels and water velocities can occur elsewhere in the floodplain due to loss of flood storage. If development decreases flood storage, the applicant shall demonstrate, at the development application stage, no detrimental impacts will occur elsewhere in the floodplain.

Marshalls Creek also forms part of Council's stormwater drainage system. Flooding of the site may occur due to flows from a localised storm event which exceeds the capacity of the creek. Future development of the site shall consider this flooding scenario and propose habitable floor levels ands evacuation paths in line with the NSW Floodplain Management Manual.

## 7.0 Riparian Zone

Generally, the NSW Department of Water identifies “Blue Line” watercourses (as shown on 1:25,000 topographic maps) as major drainage corridors. These corridors are typically associated with requirements for riparian habitat protection. The minimum riparian zone width for Marshalls Creek has been calculated at 20m. As the creek is adjacent to the western boundary of the site the riparian zone would extend 10m into the site.

However, it should be noted the final width and extent of work allowed within the drainage corridor would be subject to the habitat protection objectives - prescribed by the NSW Department of Water. The extent of the riparian zone is shown on Figure 1.0.

## 8.0 Costing

In preparing our costing for the site we have assumed no upgrading of the existing drainage channel and Marshalls Cree is necessary

| Item | Description | Rate | Total |
|---|---|---|---|
| 1 | Supply, lay, backfill, restoration of 880m of DN375 concrete pipe for inter-allotment drainage) | $93.00/m | $81,840 |
| 2 | Supply & Install 14 900 sq X 900 Deep Pits | $2040 ea | $28560 |
| 3 | Supply and install Pollution Control Device (One device to be installed per future lot) | $15,000 per unit | N/A |

Figure 8.1: Cost Estimate of major stormwater components within the site

No allowance has been made for construction of overland flow paths as this will be covered in the site works for each individual lot.

## 9.0 Stormwater Management Recommendations

Development activity is likely to increase runoff volumes and pollutant loads. Post-development flows need to be managed to minimise impacts downstream, while maintaining existing (environmental) flows to support habitats.

The following measures shall be adopted as part of an overall stormwater management system. The system shall ensure existing site flows are maintained, while minimising the effects of excessive runoff rates and volumes.

The following strategies should be employed as part of an overall stormwater management and water cycle plan.

- A Lot-based stormwater impact assessment should be provided at the Development Application Phase for each Lot. The impact assessment will need to demonstrate no adverse effects will occur elsewhere in the catchment as a result of the intended development. Stormwater management strategies such as rainwater re-use schemes; minimisation of impervious areas, permeable paving and on-site detention shall be used to achieve this outcome.

- *Rainwater Re-use Schemes* provide an alternative water source. The harvested water can easily be used for non-potable purposes (although, requirements for monitoring and treating the condition of harvested rainwater need to be considered).

- *Reducing Impervious Areas* assists to control the volume and rate of stormwater runoff. Measures to assist with optimising pervious / impervious ratios include limiting paved surfaces, incorporating of permeable paving and grass-lined corridors for drainage to complement landscaping. This strategy should be incorporated with a vegetation management plan to use native plant species.

- *Water Sensitive Urban Design (WSUD) Principles* that control the quality of stormwater discharged from the Study Area are to be incorporated (as outlined in Appendix D). Specific measures include pollution control devices, wetlands systems, bio-retention treatment facilities and maintaining site discharge rates that support environmental habitat downstream.

- Water quality targets shall be determined by the procedure indentified in Appendix C. As a minimum pollutant levels for the post-development scenario shall not exceed pre-development levels.

- Water quality targets shall be determined by the procedure indentified in Appendix C. As a minimum pollutant levels for the post-development scenario shall not exceed pre-development levels. Specific measures shall be adopted by each lot to achieve these targets.

- Provide inter-allotment drainage system within an easement (which drains to Council's stormwater system), allowing each newly formed lot to connect to a piped drainage system.

- As peak flows are likely to increase due to development, analysis of the Council's existing downstream drainage network to determine its ability to accommodate post development flows as part of the development Application (DA). The analysis shall identify any stormwater augmentation works required. In particular the capacity of the culvert where Marshalls Creeks passes under Copland Rd be analysed.

- All piped drainage systems within the site shall be designed for the 1 in 20 year ARI storm.
- Provide overland flow paths for the 1 in 100 year ARI storm to prevent inundation and safe egress of proposed existing adjacent buildings. Flow path design shall consider any future development that may occur for the lands to the north.
- Assessment of the extent of flooding (if any) from Marshalls Creek due to localised storm events.
- Assessment of impacts any reduction flood storage (where flooding of the Murrumbidgee River inundates the site) due to development in accordance with the NSW Floodplain Manual if Occurs
- Adopt guidelines as stipulated in the NSW Floodplain Management Manual for development of flood liable land.

# APPENDIX A – STORMWATER PLANNING MATRIX

## A1 Description of Matrix

The purpose of the matrix is to provide a systematic approach in identifying opportunities and constraints to stormwater management for the Study Areas associated with the 2007 Wagga Wagga Planning Study. This will then enable stormwater management measures to be implemented to optimise development, respond to specific site conditions and consider the proposed land-use.

| Study Area | Primary Land Use | No. Of "Blue Lines" | No. of C'ments | Upstream C'ment | Site Discharge Controls | Salinity Controls | Flood Liable Land | Stormwater Quantity | Stormwater Quality | Rainwater Re-Use |
|---|---|---|---|---|---|---|---|---|---|---|
| *Refer to Section A2* | *Refer to Section A3* | *Refer to Section A4* | *Refer to Section A5* | *Refer to Section A6* | *Refer to Section A7* | *Refer to Section A8* | *Refer to Section A9* | *Refer to Section A10* | *Refer to Section A11* | *Refer to Section A12* |

The Stormwater Planning Matrix identifies key issues and objectives to facilitate the planning and design of major drainage system components. The Matrix provides the framework for designers to determine solutions that will address the likely impact of proposed development. The process also seeks to inform the LES process by identifying appropriate stormwater drainage measures that are environmentally sensitive and minimise this impact.

The Goal of the Matrix is to identify the Stormwater Planning Controls associated with each of the respective Study Areas, while still encouraging innovation and best practice solutions.

Appendix A provides detailed descriptions for the criteria used to identify opportunities and constraints, as well as a method for constructing the stormwater planning framework for each Study Area.

## A2 Primary Land Use

Land-use correlates to the quantity and quality of stormwater runoff from a site. The amount of impervious area characterising the land-use is the main influence of this. As impervious area increases so does the volume of stormwater runoff and the potential for pollutant runoff. Conversely, more pervious site areas encourage ground infiltration and filter pollutants in runoff.

Typically, for urban areas, industrial lands have the highest impervious area ratio, while low density residential lands have the least. For calculation of peak runoff values for the sites nominated in the Wagga Wagga Planning Study the following post-development fraction impervious values were adopted.

| Land Use | Fraction Impervious |
|---|---|
| Low Density Residential | 65% |
| Industrial | 90% |
| Mixed Use | 85% |

With reference to the Planning Matrix:

- The "Primary Land-use" column defines the predominant type of development expected in the study area (Post-Development Case).
- *Residential development* is defined low density housing (typical lot size between 750m$^2$ and 1000m$^2$ dispersed with small pockets of commercial and special uses lands).
- *Residential development* also incorporates commercial area, roadways, open space or recreational areas normally found within this type of development.
- For portions of the study areas where *rural residential development* is proposed a lower fraction impervious value of 40% may be adopted.
- *Industrial Development* refers to employment lands used for shop fronts, light manufacturing, warehousing / stockpiling, or transport depots. Heavy manufacturing is not expected on these sites as water and sewer infrastructure could not accommodate demands. Types of operations within industrial lands needs to be considered for specific sites, as it can directly impact the quality of stormwater runoff.
- *Mixed land use* refers to commercial developments such as petrol stations, truck stops or other enterprises requiring a shop front. Types of activities on mixed use lands needs to be considered for specific sites, as this can directly impact the quality of stormwater runoff.

## A3 "Blue Line" Watercourses

The NSW Department of Water identifies "Blue Line" watercourses (as shown on 1:25,000 topographic maps) as significant drainage corridors. These corridors are typically associated with provisions for riparian habitat protection.

Protected watercourses are graded according to their ecological value. Typically, the higher the ecological value, the wider the associated riparian (protection) zone. In this instance, the width of the riparian zone can be dictated by ecological value, rather than width for conveying stormwater runoff.

"Blue line" watercourses can be ephemeral or have permanent flows. The watercourses are natural valleys or depressions within the catchment where surface stormwater runoff is concentrated. Utilising the existing topography of the study area for conveying this runoff provides the most cost-effective outcome for stormwater drainage, habitat protection and maintaining environmental flows to downstream watercourses.

## A4 Number of Catchments in Study Area

The number of catchments refers to quantity of drainage catchments within the study area. Typically each catchment will drain to a “Blue Line” watercourse. Identification of catchments forms the basis for design of catchment-based (communal) stormwater management systems.

## A5 Upstream Catchment

This column identifies whether there are upstream catchments outside of the Study Area that will contribute stormwater runoff to the site (e.g. via surface, watercourses or depressions). Flows from upstream catchments need to be considered when managing stormwater flows in each of the study area.

The capacity of proposed drainage networks within Study Areas will need to accommodate the flows from any upstream catchment – in order to maintain natural flow paths and convey safely through the site.

## A6 Site Discharge Controls

This column identifies existing downstream elements or features that will influence the rate and volume of stormwater being discharged from a Study Area.

## A7 Salinity Controls

Salinity can be managed by good stormwater management practices. Adoption of water sensitive urban design (WSUD) principles will inherently assist in the management of salinity. Some stormwater management measures such as ground water recharge or infiltration are not suitable in areas susceptible to salinity. Flagging salinity early in the planning process allows sympathetic stormwater management measures to be economically adopted.

Any stormwater infiltration mechanism that raises groundwater must be avoided in order to manage salinity. In some instances, it may also be preferable to reduce existing levels of infiltration to prevent adverse impacts of salinity.

## A8 Flood Liable Land

Flooding of land within each of the study area can occur as a result of one (1) of two (2) events:

- The Murrumbidgee River overtopping its banks or;
- A localised storm event generating stormwater runoff greater than the capacity of the formal drainage system.

The source of the flooding risk for each study area is identified in this column of the Stormwater Planning Matrix. FL1 denotes flooding is due to the Murrumbidgee River overtopping its banks or levee and inundating the subject site. FL2 denotes indicates the site is susceptible to flooding due to a storm event occurring within the catchment. Generally flood risk denoted as FL2 is due to the existing downstream drainage network being under capacity.

This assessment has not considered the potential effects of the two (2) events occurring simultaneously, due to its unlikelihood.

Appropriate site stormwater management measures are influenced by the potential for site flooding. Furthermore the cause of flooding will influence the type of stormwater management options chosen. For example, if flooding occurs due to a catchment storm event, it is desirable to discharge the peak runoff of low lying lands (or lands subject to flooding) early in a storm event to allow the maximum capacity of the drainage system to be utilised. In such instances stormwater detention would be detrimental to the lower portions of the catchment.

## A9 Stormwater Quantity Management

Urbanisation increases the quantity of stormwater runoff. As a result stormwater quantity management measures need to be adopted so the risk of flooding downstream is not increased. The principles of stormwater quantity management are outlined in Appendix B.

The quantity and rate of runoff discharged from a site can be controlled by the incorporation of stormwater retention and detention facilities into the drainage system. Source controls, such as limiting the amount of impervious area can also be incorporated in order to reduce the peak discharge from a catchment.

The baseline approach to designing for acceptable site stormwater discharge conditions is to control the peak post-development site discharge to be no greater than the pre-development scenario. This is generally to ensure the development does not increase any existing potential for downstream flooding.

Alternatively, any shortcomings in the existing drainage system to convey runoff can influence design - by dictating a maximum discharge from a catchment to suit inadequate downstream capacity. This further increases the reliance on detention and/or retention measures.

The Stormwater Planning Matrix considers design for stormwater quantity management measures according to the following categories:

- Q1 – Pre-development stormwater runoff not to exceed post development for 5 to 100 year ARI storm events for all durations.
- Q2 – Study Area or parts of Study Area located in flood prone land therefore not requiring stormwater detention.
- Q3 – Downstream discharge controls requiring flows to be limited to less than the pre development discharge rates.
- Q4 – Community-based stormwater detention facilities to be provided.
- Q5 – Lot based or on-site stormwater detention (OSD) facilities to be provided.

## A10 Stormwater Quality Management

The impact of urban stormwater on receiving waters is to be understood and managed as part of the development process. The purpose of this column of the Stormwater Planning Matrix is to identify an appropriate stormwater quality target which is dependent on the receiving waterway.

Stormwater runoff from all Study Areas forming the Wagga Wagga Planning Study will eventually flow to the Murrumbidgee River. In this regard stormwater quality targets will be defined by the Murrumbidgee Catchment Authority, in conjunction with engineering best practice.

Invariably, development activity necessitates stormwater treatment measures to be introduced to the drainage network in order to achieve water quality targets. These can be applied through community-based facilities or lot based measures. The Stormwater Planning Matrix considers design for stormwater quality measures according to the following categories:

- QA – Water quality target values which are specified by receiving waters stakeholders
- QB – Site specific values due to location, catchment conditions or site use
- QC – Community-based treatment measures to be provided
- QD – Lot-based treatment measures to be provided

## A11 Rainwater Reuse

Rainwater is defined as stormwater runoff that is collected and treated to a level that allows re-use for a specified purpose. There are numerous ways to utilise rainwater in urban catchments. The potential for rainwater reuse is dependent on the applications within the catchment that can accept rainwater as an alternative means for water supply.

Typically domestic dwellings within urban catchments can easily collect rainwater for non-potable uses - outdoor supply (e.g. irrigation, car washing), toilet flushing and clothes washing machines. Larger scale rainwater reuse facilities can also be incorporated into the drainage network by providing water for open space irrigation and water features.

Each Study Area has the potential to be serviced by a rainwater re-use system. The goal of the Stormwater Planning Matrix is to facilitate full potential for rainwater re-use. Opportunities for rainwater re-use have been identified as follows:

- RA – Lot-based rainwater re-use systems
- RB – Community-based rainwater re-use systems.

Rainwater re-use is a key component of WSUD and therefore every opportunity for incorporation into future development should be explored.

# Appendix B – STORMWATER QUANTITY MANAGEMENT

## B1 Introduction

When urban development takes place in existing rural catchments significant pervious areas are replaced by impervious surfaces. This change leads to an increase in peak catchment flows and an increased volume of surface runoff (downstream of the site).

Increasing impervious area can lead to potential for:

- Flooding of downstream property
- Increasing overland flow to extend outside defined flow paths
- Erosion of natural watercourses

Stormwater quantity management minimises these problems by controlling runoff.

## B2 Objectives

1. Development that does not increase the impact of rainfall events.
2. Development that does not adversely affect the integrity of natural waterways, groundwater and ecosystems.
3. Stormwater quantity management that is in accordance with best practice.
4. Provide stormwater quantity management measures that are functional and effective for the duration of their existence.

## B3 Performance Outcomes for Infrastructure

Best practice stormwater quantity management systems are dependent on three (3) aspects. These derive from (a) the adoption of the major / minor stormwater drainage philosophy, and (b) incorporating detention or attenuation to maintain / improve receiving waterways, habitats and infrastructure.

Major / minor drainage concepts seek to maintain convenience and amenity within the urban landscape during minor (nuisance) storm events and protection for life and property during major (excessive) storms.

Stormwater quantity management need to be considered in conjunction with the major / minor system managing runoff. While, best practice solutions will consider stormwater quality management and Water Sensitive Urban Design (WSUD) principles, also.

As a result, there is a strong interrelationship between the following aspects of design for stormwater quantity management.

### B3.1 Minor Stormwater Drainage System

The minor drainage system comprises the drainage network components that provide convenience and safety to pedestrians and traffic during frequent or minor storm events by controlling catchment flows within prescribed limits. The minor drainage system consists of kerbs, gutters, roadside channels, swales, stormwater pipes and pits designed to contain and convey stormwater runoff for events up t and including minor storms.

The minor drainage system shall be designed to contain and convey the peak flow due to the 5 Year ARI storm.

### B3.2 Major Stormwater Drainage System

The major drainage system incorporates drainage components that ensure residential, commercial, industrial and other habitable areas are protected from inundation during major storm events. The major drainage system consists of roadway reserves, open space areas, floodway channels, and natural watercourses to contain and convey stormwater runoff due to a major or infrequent storm event. Design of the major system is to occur at the Master Plan stage of development, so that a satisfactory level of safety and amenity is provided, whilst preventing devastation caused by major (excessive) storm events.

The major system shall be designed to contain and convey the peak flow due to the 100 Year ARI storm. These systems are to be designed so that velocity/ depth conditions are within prescribed limits.

### B3.3 Stormwater Detention/Attenuation

Stormwater runoff from the post-developed catchment condition is to be retained so that the flow characteristics of receiving waters are improved or as a minimum unchanged from pre-development conditions. This is typically achieved by providing detention / attenuation measures as part of the major drainage system.

In some circumstances, pre-existing flooding conditions downstream or inadequate capacity of receiving infrastructure, watercourses or topography, may require reducing post-development catchment discharge to less than pre-development levels.

## B4 Catchment Discharge Control

Catchment discharge controls are the detention or attenuation measures (such as detention basins, lagoons or rainwater tanks) that control the volume and rate of stormwater discharged from a catchment.

### B4.1 Stormwater Discharge Limits

Discharge control facility design values are defined by the capacity of the receiving waters to accept flows from the catchment. The following limits are to be maintained as the study areas are developed.

| Planning Matrix Code | Description | Catchment Discharge Limit |
|---|---|---|
| Q1 | Pre-development vs. Post development | Post-development catchment discharge not to exceed pre-development catchment discharge for 5 year to 100 year ARI for all durations. |
| Q2 | Flood Liable | Catchment located in Flood Prone areas that does not require provision for stormwater detention facilities. Retention facilities, such as rainwater re-use still need to be provided to meet the objectives of WSUD. |
| Q3 | Downstream Controls | A downstream condition exists where catchment discharge needs to be reduced to less than pre-development levels. The control conditions for each study area are identified in the main body of the report. |

The application of discharge controls should consider environmental flows of the receiving waters. Discharge controls may create higher, more frequent peak flows, during small events. A balance is to be struck between controlling peak flows, yet maintaining an acceptable level for environmental flows that will ensure the health of natural water courses and associated habitats. Guidelines for provision of environmental flow, is described in detail in Appendix C.

## B5 Stormwater Quantity Management Measures

The following measures will need to be considered to minimise the effect of development on downstream stormwater infrastructure:

### B5.1 On-site Stormwater Detention

On-site Stormwater Detention (OSD) allows for the storage and controlled release of stormwater runoff. OSD is designed to ensure stormwater runoff from new development sites does not exceed the allowable discharge rates that are (a) able to be accommodated by the existing (downstream) system, and / or (b) equal to existing site flows.

On-site stormwater detention facilities will be provided at a local catchment level. The facilities are best located:

- Toward the downstream end of sites,
- Outside riparian/conservation corridors and discharge so as not to affect these areas,
- Outside areas susceptible to flooding (up to 100-year ARI), and
- So that connections are not susceptible to backwater from downstream drainage systems.

Care needs to be taken to ensure that stormwater runoff from the development site is not reduced to a level that affects environmental flows supporting downstream aquatic habitats.

### B5.2 Stormwater Retention (Attenuation)

Stormwater retention reduces site runoff discharging to the downstream drainage system. Stormwater is captured to provide an alternative water supply source – thereby conserving mains water consumption. Rainwater can be an alternative source of supply for non-potable and potable water-use purposes – depending on the level of treatment.

Stormwater retention/re-use systems can be applied to individual lots or at a local level. The capacity of individual lots systems can vary from 3,000 to 10,000 litres. The size of local systems is dependent on the demand and use (e.g. irrigation, non-potable water supply to residential lots, etc.).

### B5.3 Optimising Impervious Site Areas

Encouraging pervious site areas reduces the effect of increasing runoff due to paved / hard surfaces. Planning to optimise pervious and impervious spaces can lead to reducing development site runoff. This might consider:

- Permeable paving for public access areas and/or residential driveways/pavements. This will be subject to installing filtration media and subsurface drainage systems – where clay / impermeable soils exist on-site.
- Grassed swales for collecting and conveying stormwater runoff. Again, this will be subject to installing trickle drain / filtration media and sub-surface drainage systems to avoid saturating ground immediately under grass / vegetation.
- Limiting paved surfaces.

### B5.4 Off-Site Works

Scope may exist for an infrastructure augmentation strategy. Typically, permissible site discharge is governed by the capacity of the receiving drainage system. A cost-effective approach may be to augment downstream drainage infrastructure to improve capacity to cater for site flow. Such a strategy may reduce the amount of OSD required on the site and subsequently increase developable area.

# Appendix C – STORMWATER QUALITY MANAGEMENT

## C1 Introduction

Urban development typically increases impervious surfaces within a catchment, leading to potential increase in stormwater runoff. During regular rainfall events, runoff flushes pollutants that have been deposited during dry periods, resulting in higher pollutant loads reaching the receiving waters. To this end, rural runoff is of a higher quality than urban runoff.

Development within the City of Wagga Wagga involves converting rural lands to urban landscapes. As a result, stormwater quality management becomes critical. The impact of the pollutants depends on the pollutant, the sensitivity of the receiving watercourse and the concentration of the pollutants at the point of entry.

## C2 Objectives

1. Protection of aquatic and terrestrial environments
2. Minimise disturbance to catchments downstream of the study areas
3. Regular rainfall events do not adversely affect water quality
4. Compliance with legislation

## C3 Background

The major drivers of impacts on receiving waters that need to be considered in managing stormwater quality are as follows:

- Toxicants (heavy metals, hydrocarbons, pesticides, ammonia)
- Nutrients (phosphorus, nitrogen, carbon)
- Oxygen demanding substances (organic material (biochemical oxygen demand), ammonia, hydrocarbons, sulphides)
- Physical contaminants (suspended solids)
- Change in stream flow levels and frequency
- Microbial pathogens (enteric viruses, bacteria, protozoa, helminths)

- Aesthetic contaminants (organic and anthropogenic litter, hydrocarbon, nuisance algal-related scums, anaerobic-related scums and odours).

*(Source –Australian Runoff Quality 2006)*

Contamination of a waterway occurs when the concentration of an element is greater than natural levels. Current practice determines stormwater quality targets by assessing risk to the specific ecosystem to which stormwater runoff is being discharged.

"Trigger" levels, below which there is a low risk of harm to the environment, are being adopted instead of adoption of absolute values. If the trigger level is exceeded further analysis is required to determine ecosystem response.

The above concepts have been drawn from ANZECC Guidelines.

Table 3.1: Typical water quality values for urban runoff and guideline values:

| Variable (mg/L unless otherwise indicated) | Urban Runoff | Urban Guidelines |
|---|---|---|
| SS | 250 (3-1620) | <25 |
| BOD | 15 (7-40) | <2 |
| Lead | 0.01-2.0 | <0.025 |
| Zinc | 0.01-5.0 | <0.05 |
| Copper | 0.4 | <0.01 |
| Chromium | 0.02 | <0.01 |
| Cadmium | 0.002-0.05 | <0.0004 |
| Faecal Coliforms (orgs/100mL) | $10^4$ ($10^3$-$10^5$) | <$10^3$ |
| Total Phosphorus | 0.6 (0.1-3) | <0.05 |
| Ammonium | 0.7 (0.1-2.5) | <0.2 |
| Oxidised Nitrogen | 1.5 (0.4-5) | |
| Total Nitrogen | 3.5 (0.5-13) | <0.5 |

Note:
1. Table sourced from Australian Runoff Quality 2006
2. SS = suspended solids
3. BOD = biochemical oxygen demand

## C4 Stormwater Quality Management Controls

The above guideline values can be used to plan stormwater quality management facilities for each study area. Further investigations will be required to design an appropriate stormwater quality management system.

Targets and controls for Stormwater Quality management are to be selected in accordance with the procedure presented in Chapter 7 of Australian Runoff Quality – A Guide to Water Sensitive Urban Design.

Selection of stormwater quality targets is a two phase process.

- Phase 1 - select trigger values for stormwater runoff contaminant loads. This is undertaken by utilising the ANZECC / ARMCANZ water resources and management framework to identify environmental and use values of the receiving waterway.

The trigger values represent a runoff quality level that must be met to in order to limit the risk to the values to acceptable levels.

- Phase 2 - estimate the Permissible Average Annual Export Load (PAAEL) for the catchment to be compared to the trigger values for the receiving waters. The design of stormwater quality measures will address the imbalance between the untreated PAAEL and the trigger values.

The above process recognises the differences in the way contaminants may enter stormwater runoff as well as the variable impacts contaminants may have on the receiving waterway. Furthermore by adopting trigger levels, a more efficient design process is achieved, by limiting the need for field sampling and laboratory analysis to situations where the risk of impact of the development has increased.

## C5 References


ANZECC / ARMCANZ - Australian and New Zealand Environment and Conservation Council/ Agricultural and Resource Management Council of Australian and New Zealand

ARMCANZ and ANZECC (1994), National Water Quality Management Strategy: Policies and Principals

Environment Australia (2000), ANZECC / ARMCANZ Guidelines for Fresh and Marine Water Quality, 2000

Engineers Australia (2006), Australian Runoff Quality A guide to Water Sensitive Urban Design

# Appendix D - Water Sensitive Urban Design (WSUD)

## D1 Introduction

Water Sensitive Urban Design (WSUD) integrates urban water cycle management with urban planning and design. WSUD drives the beneficial outcomes to the built environment by:

- Improving the urban landscape
- Reducing pollutant export
- Retarding storm flows
- Preserving the natural hydrological regime of catchments
- Reducing irrigation requirements
- Reducing demand on the potable water supply

In practice, WSUD aligns innovative water management technologies within the built environment. The goal of WSUD is to bring together the water environment and infrastructure service design at the early planning stages. WSUD is applicable to a range of projects, scaling from individual house lots to new communities.

Underpinning the approach to water sensitive urban design is that stormwater is to be managed as a resource and for protection of the environment.

## D2 WSUD Best Practice Approach

Implementation of WSUD utilises three strategies (1) stormwater quantity management, (2) stormwater quality management, and (3) stormwater as a resource. Stormwater quality and quantity management have been outlined in Appendix B and C respectively.

## D3 Stormwater as a Resource

Traditionally roof stormwater runoff is directed to the street stormwater drainage system. In response to climate change, particularly where many parts of Australia are experiencing severe and extended periods of drought, such an approach is considered to discourage water conservation.

As a result, a key strategy for WSUD is to capture roof runoff. A direct benefit of this strategy is the reduction of demand on the potable water supply. Typical uses for rainwater for non-potable water supply include:

- Toilet Flushing
- Irrigation
- Car Washing / Wash down water
- Manufacturing processes
- Air Conditioner Chillers

Stormwater re-use facilities can be provided on an individual lot basis or as a community-based scheme. The continuation of variable rainfall patterns is leading to more and more opportunities for stormwater re-use. Stormwater re-use also supports stormwater quantity management, by reducing the volume of stormwater runoff emanating from a site.

## D4 WSUD Planning and Design Tools

Several planning and design strategies are presented below to assist with the implementation of WSUD initiatives.

### D4.1 Open Space Networks

WSUD integrates drainage corridors into public open space areas. Furthermore these areas can function as conservation corridors. The alignment of the corridors would typically follow "blue line" watercourses or outer natural depressions in the topography.

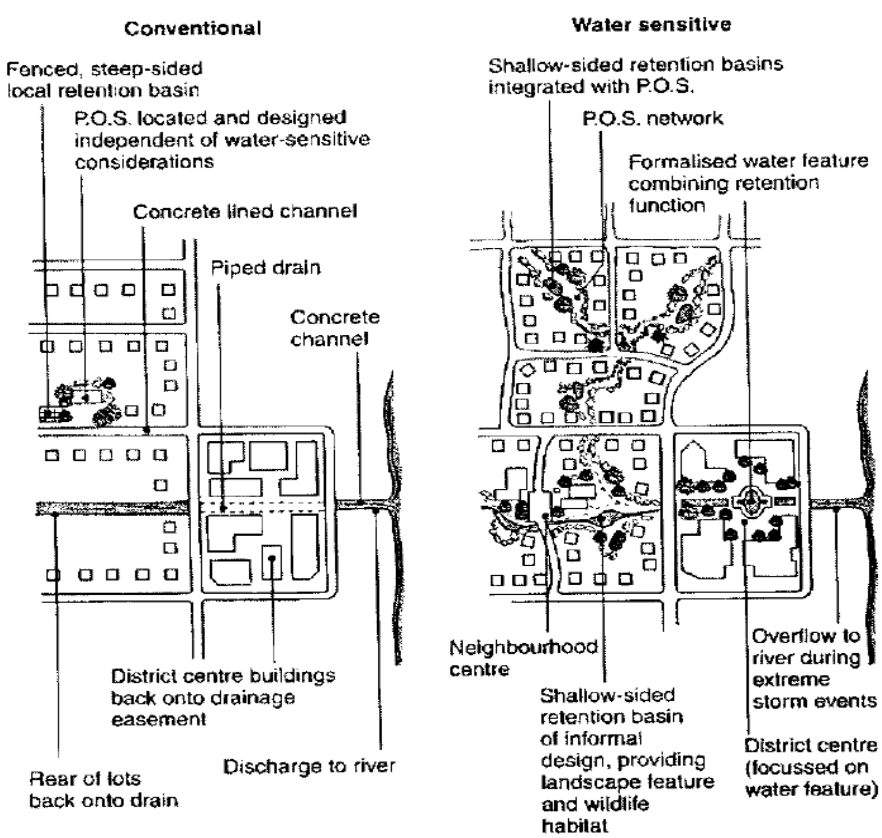



Figure D4.1 Open space network (Source: Engineers Australia 2006)

Recreation facilities adjacent to drainage facilities can introduce risks to public health and safety. The risks can be addressed by control measures such as warning signs and safety fencing. Risk assessment during the planning stage of the project should be undertaken to limit all risk to acceptable levels. Figure D4.1 shows a typical open space layout

## D4.2 Lot Layout

WSUD encourages a more compact form of development to minimise impervious surfaces. Lot layouts should be designed so that individual properties are integrated with the drainage function of the open space networks.

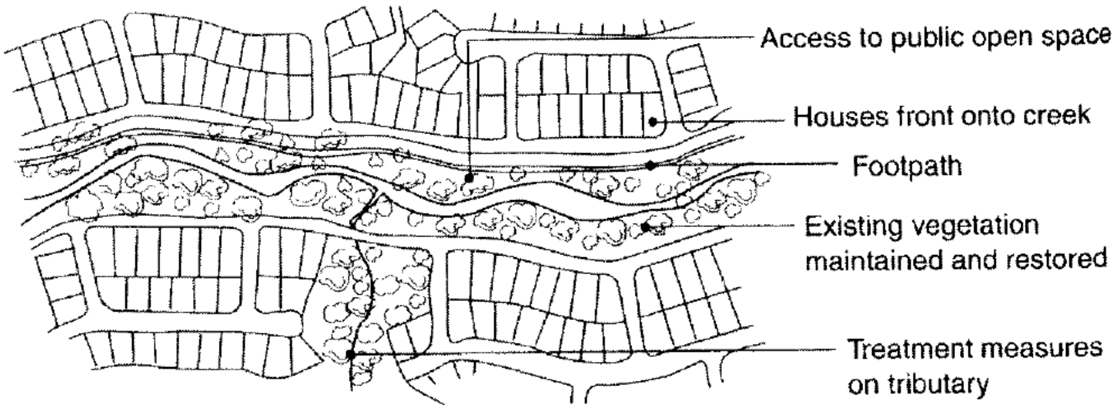



Figure D4.2 Integration of lots with open space corridors (Source: Engineers Australia 2006)

## D4.3 Road Layout

WSUD utilises the natural features of the site to develop the road layout. Roads are generally located beside open space networks / corridors. This serves to (1) enhance recreation amenity, (2) locate detention and pollution treatment facilities close to the discharge point / source.

This approach assists to reduce the surface area of roads. The concept is shown in Figures D4.2 and D4.3.

## D4.4 Streetscape

WSUD integrates vehicular and pedestrian requirements with stormwater management facilities. Typical methods include, zero lot lines, reduced frontages and placing stormwater detention and treatment facilities in road reserves.

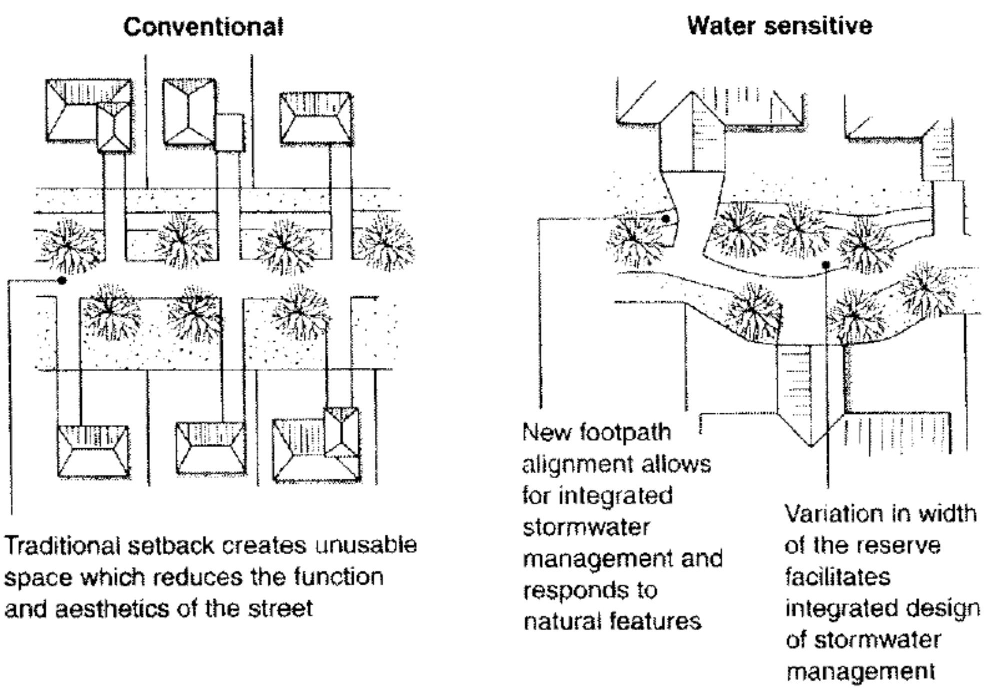



Figure D4.3 Conventional and WSUD road layouts (Source: Engineers Australia 2006)

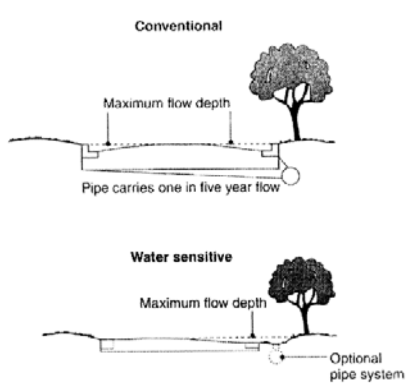



Figure D4.4 Conventional and WSUD road cross section (Source: Engineers Australia 2006)

## D5 Summary of Water Sensitive Urban Design Elements

Several of the commonly used WSUD elements are described in this Section. Typically a combination of these elements is used to manage stormwater from developed sites.

### D5.1 Sediment Basins

Sediment basins are designed to remove coarse sediments from stormwater runoff. A sediment basin removes particles by slowing water velocity to allow sediments time to fall to the bottom of a water column. Sediment basins are provided early in the treatment process and prevent downstream waterways becoming clogged.

Sediments basins require frequent maintenance. Maintenance activities included dewatering of the basin then removal of the collected sediment from the invert of the basin. Sediment basins can be designed to completely drain after a rainfall event or have a permanent pond.

Figure D5.1 Typical sediment basins (Source: Melbourne Water)

### D5.2 Bio-retention Swales

Bio-retention swales are bio-treatment systems located at the base of a swale. They provide treatment by filtering stormwater through a filter media such as sand. Furthermore, bio-retention swales detain stormwater runoff and act as a conveyance system (instead of pipes).

Bio-retention swales are commonly located in the median strips of roadways. Bio-retention swales offer efficient removal of nitrogen and other contaminants.

Bio-retention systems allow water to permeate through a filter media. The water is then infiltrated into permeable site soil or collected in an underlying perforated pipe / drainage system where impermeable soils are present. This arrangement can make bio-retention swales suitable for areas affected by salinity.

The performance of the bio-retention swale is enhanced by introduction of vegetation by prevent clogging and scouring of the filter material.

Figure D5.2 Typical bio-retention swales (Source: Melbourne Water)

## D5.3 Bio-retention Basins

Bio-retention basins operate in a similar manner to bio-retention swales, except that they do not convey stormwater. Bio-retention basins are "off-line" systems - where large flows are diverted away from the basin.

Bio-retention basins can be integrated into landscape areas and constructed in any shape or size to suit the application. Bio-retention basins work effectively by placing them at regular intervals in the roadway to form traffic calming devices or parking bays.

Figure D5.3 Typical bio-retention basins (Source: Melbourne Water)

### D5.4 Swales or Buffer Systems

Vegetated swales can be used to transport stormwater in lieu of pipes. The inherent interaction of stormwater with vegetated swales slows runoff and allows coarse sediment to remain within the catchment. In addition, swales can add to the aesthetic character of a development.

Swales are not suited to steep sites, as high velocities can result. Conversely swales constructed at flat grades (i.e. less than 2%) tend to become waterlogged. Trickle drains should be considered where soils have potential to become saturated.

Figure D5.4 Swale and buffer system (Source: Melbourne Water)

### D5.5 Wetlands

Constructed wetlands are vegetated water bodies that promote removal of pollutants from stormwater. Pollutants are removed by sedimentation, filtration and pollutant uptake by the vegetation.

Wetlands are made up of various zones, each with a different treatment function. Stormwater passes through each of these zones to obtain the desired water quality. Wetlands can provide a habitat for wildlife and can form part of recreation areas. Wetlands can vary in size to suit the site, land-use and level of treatment required.

Figure D5.5 Wetlands (Source: Melbourne Water)

### D5.6 Rainwater Tanks

Rainwater tanks provide two benefits to development. Firstly they encourage water conservation, and secondly they reduce the quantity of stormwater discharged to downstream waterways. Rainwater tanks also assist in reducing pollutant loads in stormwater discharge.

Rainwater storage can be provided on a lot by lot basis or as a community storage facility. Community facilities should always be considered in any project, as they offer a cost-effective means of providing rainwater harvesting to a large number of properties.

Generally, roof water is directed directly to rainwater tanks via a first flush flow treatment device. Surface water needs to be substantially treated prior to collection and re-use.

The size of the tank is dictated by the water demand of the services it supplies. If the service is totally reliant on supply from the tank, additional storage provisions need to be provided so that water is available during extended dry weather periods.

## D5.7 Aquifer Storage and Recovery

Aquifer Storage and Recovery (ASR) is the process where ground water supplies are recharged to counteract the effects of water extraction. ASR can also be adopted as part of a salinity management strategy. Typically excess stormwater from development (or land clearing) can be harvested, treated and injected back into the groundwater supply. The viability of an ASR scheme is dependant on the underlying geology of a development site and in particular the presence of natural aquifers.

## D6.0 References


Engineers Australia (2006), Australian Runoff Quality - A Guide to Water Sensitive Urban Design

Melbourne Water (2005), WSUD Engineering Procedures: Stormwater